Simulation Study of an Extended Divertor Leg for Heat Control in SlimCS DEMO Reactor

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The tokamak demonstration reactor, SlimCS, is designed to generate the fusion power of ≤ 3 GW with a low-aspect ratio and a reduced-size center solenoid for economic viability [1, 2]. In the present scenario for power handling, the exhausted power into the SOL/divertor region is expected to be 500-600 MW. On the other hand, the desirable heat load on the divertor target is less than that of ITER (10 MW/m^2). The power handling in the SOL/divertor region is one of the crucial issues for the demo reactor design.

Divertor design of SlimCS has progressed using the suite of integrated divertor codes SONIC [3, 4]. The basic divertor design concept is similar to that of ITER. The SONIC simulation with the non-coronal radiation model has demonstrated that the detached divertor plasma was formed by installing the V-shaped corner and using the gas puff and Ar impurity seeding [5]. In order to investigate the Ar impurity transport in detail, the SONIC simulation with the impurity Monte-Carlo model has been performed [6]. A fraction of the Ar density to the deuterium ion density increased compared with the non-coronal model, and the radiation profile was localized close to the target. Although the heat load due to the parallel plasma transport was significantly reduced by the above effects, the contribution of the impurity radiation and the surface recombination to the target heat load became large. As a result, the peak heat load at the outer divertor target was estimated to be 18 MW/m^2.

For further reduction of the total heat load including contributions of the impurity radiation and the surface recombination, a new divertor concept, such as the snowflake divertor [7], the super X divertor [8] etc, is one of the possible solutions. In this study, as a preliminary step of such approaches, the outer divertor leg of the SlimCS is extended. The SONIC simulation is carried out in order to investigate the effect of the long divertor leg on the divertor performance, such as detachment controllability, plasma-wall interaction, impurity transport, radiation profile etc. In the presentation, controllability of the radiation profile in the long divertor region by seeding several kinds of impurity will be also discussed.

References

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